Sandia Water Power Technologies Capabilities

Sandia's Water Power Technologies program conducts applied research to increase the viability of marine hydrokinetic (MHK) technologies and reduce the cost of energy.

MHK technologies include current energy conversion (CEC) devices, e.g., hydrokinetic turbines that extract power from water currents (riverine, tidal, and ocean) and wave energy conversion (WEC) devices that extract power from wave motion. Sandia's MHK research leverages decades of experience in engineering and design and analysis (D&A) of wind power technologies, and its vast research complex, including high-performance computing (HPC), advanced materials and coatings, nondestructive inspection, complex systems simulation, and large-scale testing. Research projects often involve highly collaborative partnerships between Sandia, industry, and academia to respond quickly with impactful results.

Reference Model Project

Sandia promotes open-source MHK research by disseminating information on MHK technology point designs initially developed as reference models to benchmark performance and costs. Open-source products, including a detailed methodology for the design and analysis of MHK devices, are available at the project web site: http://energy.sandia.gov/rmp.


RM#2 River Turbine

RM#1 Tidal Turbine

RM#3 WEC Point Absorber

Open-Source Codes

Sandia develops open-source codes for MHK device and array design and analysis, including CACTUS (CEC device D&A), WEC-Sim (WEC device D&A), SNL-SWAN

(WEC array D&A), and SNL-EFDC (CEC array D&A); all available on GitHub online repositories for download and further development by the open-source community.
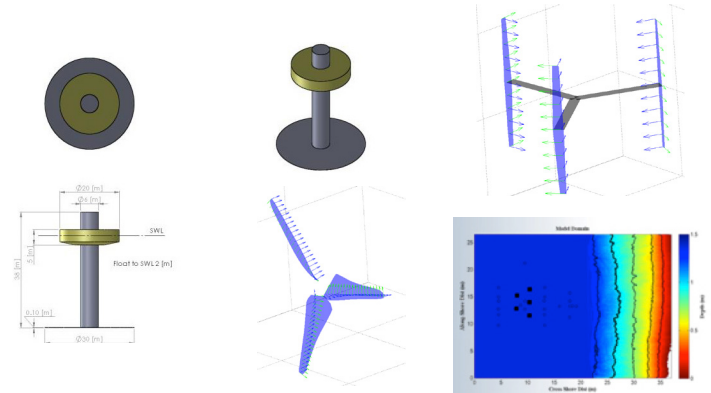

Sandia's work on open-source codes such as WEC-Sim (Wave Energy Converter Simulator, top left), CACTUS (Code for Axial and Cross-flow Turbine Simulation, center diagonal), and SNL-SWAN (Simulating Waves Nearshore, bottom right) provide all users with high- and medium-resolution models to optimize MHK energy-capture.

High-Performance Computing

Sandia leverages its world-class HPC assets to advance MHK technologies using computational fluid dynamics (CFD) models to analyze complex flow interactions and power performance.
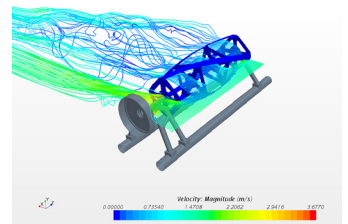

CFD simulation of complex flow in wake of ORPC's RivGen® turbine (top), the Sandia turbine (center), and a WEC point absorber (below).
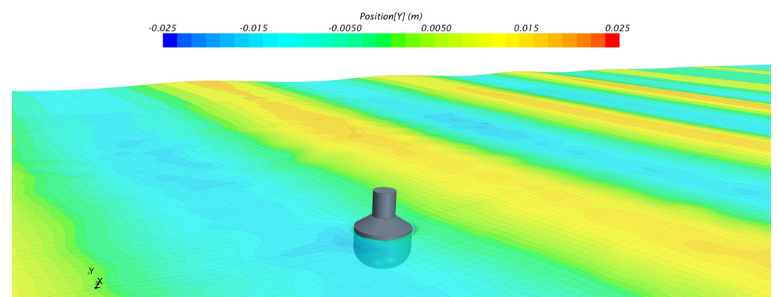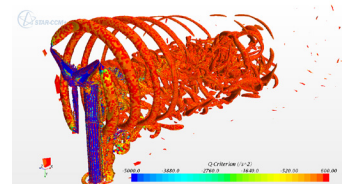
Laboratory & Field Testing

Sandia conducts laboratory and field tests to evaluate MHK technology performance and to validate and verify numerical models. Sandia also develops instrumentation systems and sensors to support laboratory and industry testing needs.
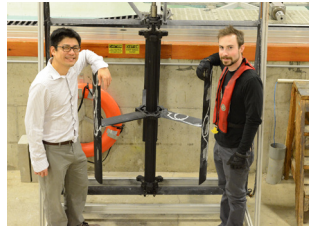

Installation of fiber Bragg grating (FBG) sensor system on turbine tested at the University of New Hampshire.
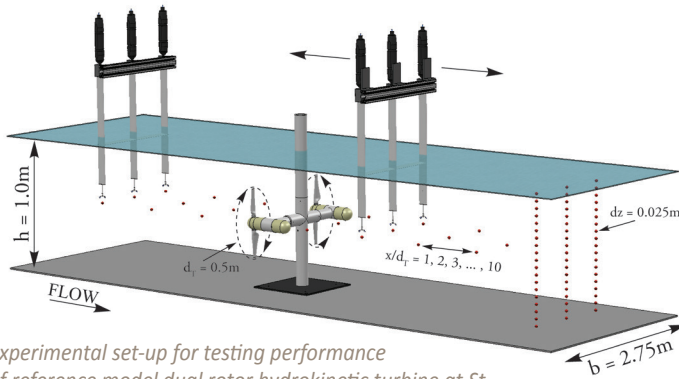
Experimental set-up for testing performance of reference model dual rotor hydrokinetic turbine at St. Anthony Falls Laboratory, at the University of Minnesota.

Materials Research

Spanning the MHK and wind research areas, Sandia's Advanced Materials Program is a core competency dedicated to performing research in materials, coatings, adhesives, and manufacturing processes to produce reliable, cost-effective renewable-energy devices.
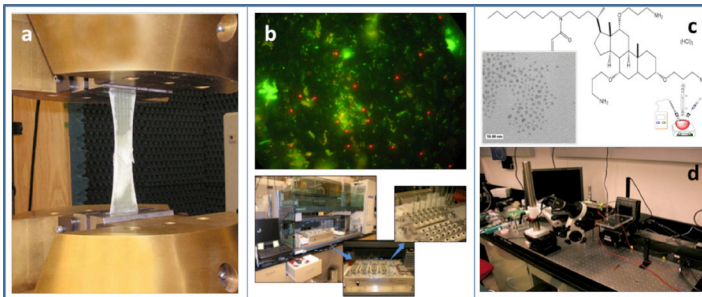
Material Testing: (a) composite fatigue, (b) biofouling & marine coatings assessment, (c) antimicrobial & anticorrosion materials development, and (d) corrosion & reliability evaluation.

Resource Assessment

Sandia catalogues critical wave statistics needed to determine the magnitude and quality of power resources at wave sites, as well as environmental loads required for WEC design.
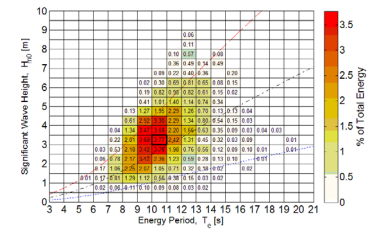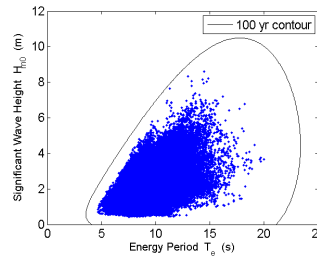
Extreme sea state 100-year contour generated with improved I-FORM method developed by Sandia (left). Wave energy distribution among sea states at wave site (right).

Environmental Analysis

Sandia develops tools and strategies to monitor and mitigate effects of MHK devices and arrays in order to facilitate project permitting and reduce regulatory costs/time for deploying MHK systems. 'MHK friendly' tools are developed and used to optimize MHK array layouts to maximize energy capture while minimizing environmental concerns.
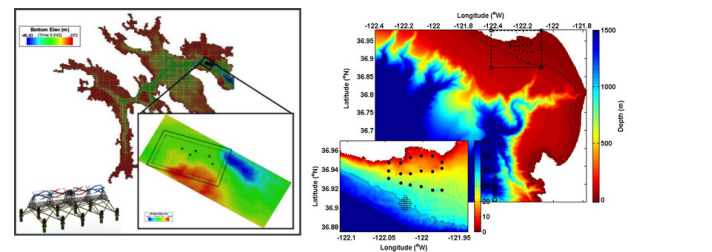
Modeling the environmental effects of MHK arrays in tidal currents (left) and waves (right).

Turbine Design

Leveraging Sandia's strong background in wind-turbine rotor design and analysis, Sandia applies a variety of fluid- and structural-dynamics modeling tools to design MHK turbines, including the Sandia turbine, developed to minimize power performance losses from soiling/ bio-fouling, and to reduce the likelihood of cavitation.
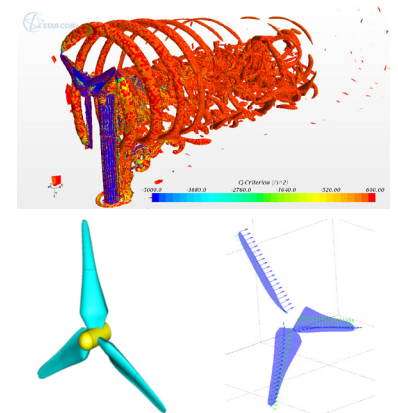
Design and analysis of the Sandia turbine using CACTUS and CFD models. Numerical models were validated with water tunnel experiments conducted at the Applied Physics Lab at Penn State.

For more information please contact:
Daniel Laird
E-mail: dllaird@sandia.gov
Phone: (505) 844-6188
Website: energy.sandia.gov